The morphology of mature larvae of three species injurious to red pine cone from Korea (Lepidoptera)

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Abstract: The larval external morphology of *Dioryctria abietella* (Denis and Schiffermüller), *D. sylvestrella* (Ratzeburg) (Pyralidae) and *Eupithecia abietaria debrunneata Staudinger* (Geometridae) of Lepidoptera is described and illustrated.

Key words: Lepidoptera; Pyralidae; Geometridae; larval morphology; Korea

The cone moths of *Dioryctria abietella*, *D. sylvestrella* (Pyralidae) and *Eupithecia abietaria debrunneata* (Geometridae) are of worldwide distribution in Korea. Their larvae are injurious to conifers, usually severely damaging the red pine cones. Feeding may also occur within terminals and upon the cambium of limbs and trunks. The larval morphological study is important for the phylogenetic classification and the morphological identification in the larval stage is also necessary for economically important species. Here we provide detailed descriptions and illustrations of the larvae of the three moths.

Mutuura (1958, 1959, 1971) and Mutuura and Munron (1969, 1974) described America, Canada, Japan and Indian species of *Dioryctria*. Neunzig (1964) described and illustrated the larvae of the genus *Dioryctria* in the southeastern United States. Issiki (1969) reported briefly the major features of *Dioryctria abietella* and *D. sylvestrella* larvae. Nishiguchi (1963) briefly described the larval color pattern and major characters of *Eupithecia abietaria debrunneata*.

Materials and Methods

The morphological features of the body of mature larvae in 70% alcohol were examined. Then, the larvae were macerated in 10% KOH for several minutes and dissected under stereoscopic microscope (40×). The head capsule with attached mouthparts was first removed from the body by a cut made with a fine forceps around the edges of the occipital foramen. The maxillae and labium as an unit were removed from the head capsule. The head was sketched under this condition from dorsal and ventral sides. Then the mandibles with attached tendons were removed from the head capsule. Mouthparts and skins were mounted on microscopic slides for detailed examination (100× or 150×).

The nomenclature of larvae setae and puncture follows Hinton (1946), and the terminology of labrum, maxillary lobe, and palpi follows Heinrich (1916), Grimes and Neunzig (1986a, 1986b).

Descriptions

Family Pyralidae

Subfamily Phycitinae

Genus *Dioryctria* Zeller, 1846

***Dioryctria abietella* (Denis and Schiffermüller)** (Figs. 1 ~ 6)

Tinea abietella Denis *et* Schiffermüller, 1775, *Ark. Syst. Work. Schmett. Wien.*: 138. (Adult)

Tinea decuriella Hübner, 1796, *Samml. Eur. Schmett.*: 8. (Adult)

Pinipestis abietella: Grot, 1878, *Bull. U. S. Teol. S.* 4:

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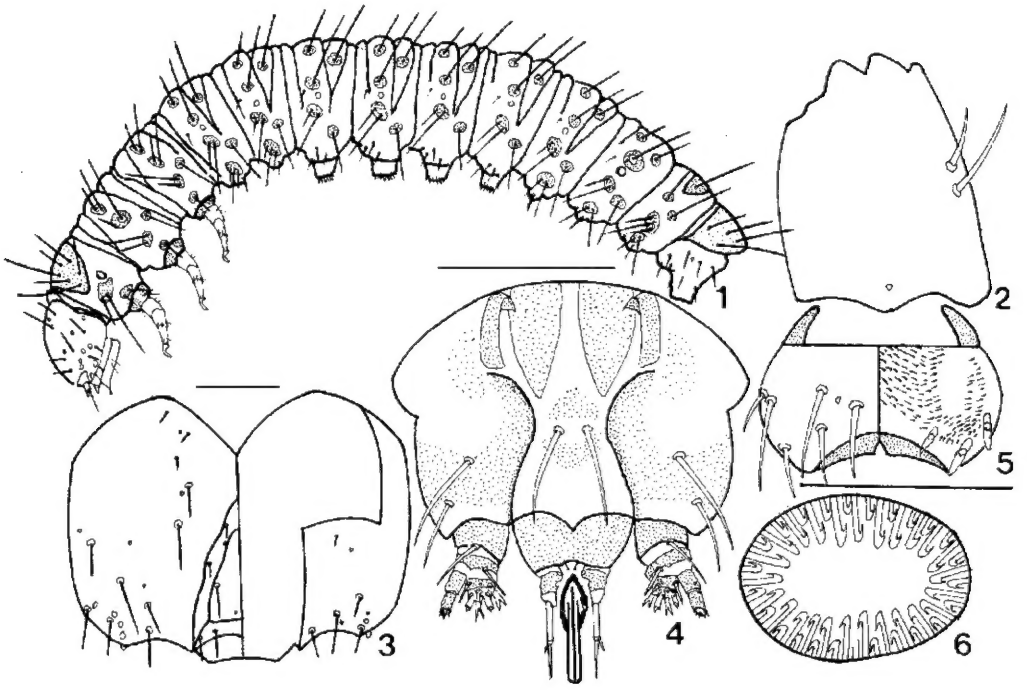
收稿日期 Received: 2001-03-08; 接受日期 Accepted: 2001-12-10



Figs. 1 – 6 *Dioryctria abietella* (Denis and Schiffermüller)
1. larva; 2. mandible (dorsal view); 3. head (dorsal and ventral view); 4. maxillae and labium; 5. labrum and epipharynx; 6. crochets. scales: 0.5 mm

701. (Adult)

Myelois elegantella Hulst, 1892, *Canad. Ent.* 24: 59. (Adult)

Dioryctria abietella: Shibuya, 1927, *Ins. Mats.* 2 (2): 92; Inoue, 1954, Check list of the Lepidoptera of Japan: 138; Mutuura, 1958, *Pub. Ent. Lab. Coll. Agric. Univ. Osaka Pref.* 4: 1-10; Forestry Research Institute, 1969, A list of forest insect pests in Korea: 91; Inoue, 1982, Moths of Japan, 1: 397, 2: 251, pl. 48: 1; Park, 1983, Insecta Koreana. 3: 152; Hirashima, 1989, A Check list of Japanese Insects ‖ : 964; Byun, 1998, *FRI. J. For. Sci.* 59: 77. (Adult)

Upper region of body usually reddish purple, ventral pale reddish green; head dark reddish brown with more or less distinct dark brown maculations; thoracic shield dark brown; anal shield light brown; setae pinacula distinct and darker than the body color; spiracles yellowish brown with dark brown peritrems.

Head. Ocellar area more rounded than angular; the distance from vertical triangle to apex of ecdysial lines greater than the distance from apex of ecdysial lines to apex of frontal sutures; the front extending about two-thirds of distance to vertical triangle. A1, A2 and A3 forming an obtuse angle at A2.

Mouthparts. Labrum emargination one-fifth deep, forming a normal arc; M2 laterodorsal to M1; L1 and L2 closely approximate, L1 slightly posterodorsal to L2. Mandible with five apical teeth on cutting edge. Labium having membranous postmentum with two conspicuous setae; mentum sclerotized; prementum with median spinneret distally and labial palpi laterally; spinneret rounded at apex, about 5 times as long as median breadth, and almost equal to tip of seta on apical segment of labial palpi. Maxillae: cardo mostly membranous, with hook-like sclerites basally; stipes mostly membranous, with large sclerites and two setae; palpifer sclerotized, with one seta. Palpus: basal segment with a maxillary lobe and one seta, on the lobe with three sensilla trichodea (two setae forked), two sensilla styloconica, and three sensilla basiconica and one puncture; median segment equal to apical segment and with one puncture; apical segment with eight small sensilla basiconica distally.

Thorax. T1: D1 slightly closer to XD1 than D2; XD2, SD1 and SD2 forming an acute angle at SD1; L1 and L2 positioned posterior of L pinaculum; SV1 and SV2

present above leg. T2 and T3: D1 and D2; SD2 and SD1 on same pinacula; L1, L2 and L3 present, L1 and L2 on the same pinacula; SV group unisetose; a dark ring around seta SD1 and center pale on T2. Thoracic leg: coxa with seven setae; femur with two setae; tibia with six setae and one puncture; tarsus with small spines and four short setae near claw.

Abdomen. On A1-8, D1 anterodorsal to D2; SD1 long and dorsal to spiracle; a dark ring rounded SD1 seta and center pale on A8; SD2 present; L3 posteroventral to L1 and L2 pinaculum. On A9, D2 pinaculum fused from dorsum; D1 closer to SD1 than D2; with 3 L setae. Anal shield rounded posterior, anal leg with nine setae and one puncture. SV group on abdominal segments 1, 2, 7, 8 and 9 usually 3:3:2:2:2. Crochets on A3-6 biordinal, arranged in a circle; anal legs with semi-circle biordinal crochets. All spiracles circle, those on T1 and A8 of about the same size, larger than the others.

Larva length: 18 ~ 26 mm. Head width: 2.1 ~ 2.5 mm.

Materials examined: Mature larvae collected from cones of *Pinus koraiensis* S. *et* Z. at the Experiment Forest of Kangwon National University, Chunchon City, Kangwon Do, 9. Ⅸ. 1997.

This species is easily separable from the relatives by the maxillary lobe with two forked sensilla trichodea; a dark ring rounded seta SD1 and center pale on T2 and A8; setae D1 and SD1 pinaculum separate on A9; setae L1 and L2 positioned posterior to L pinaculum on T1.

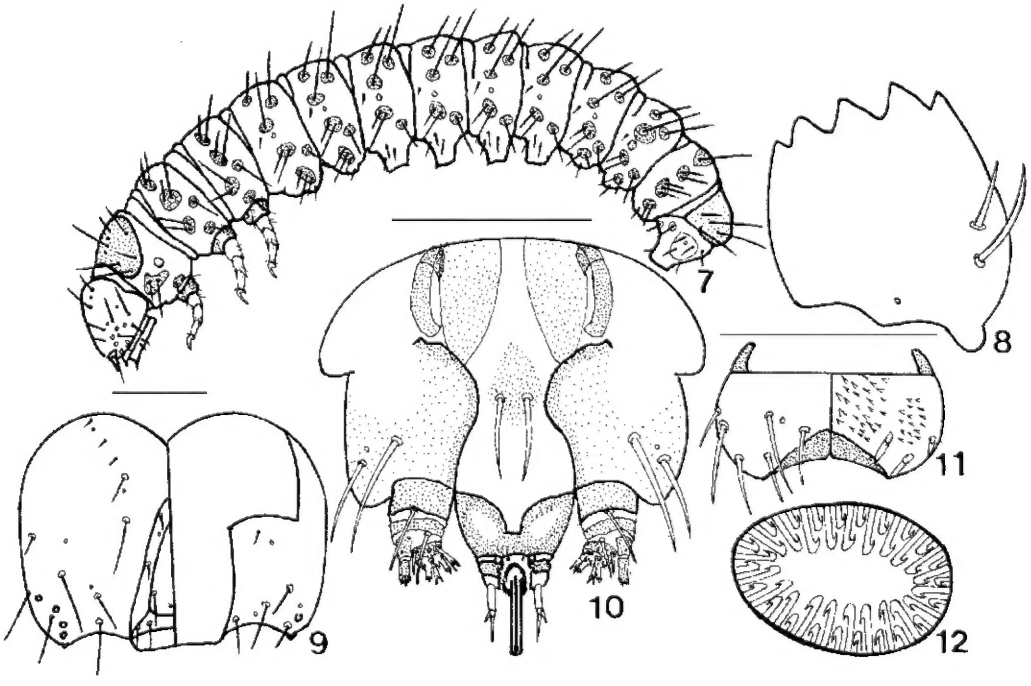
Dioryctria sylvestrella (**Ratzeburg**) (Figs. 7 ~ 12)

Tinea sylvestrella Ratzeburg, 1840, *Forest. Ins.* Ⅱ: 242. (Adult)

Nephopteryx splendidella Herrich-Schäffer, 1847, *Syst. Bearb. Schmett. Rur.* 4: 79. (Adult)

Diortctria splendidella: Ragonot, 1888, *Ent. Mon. Mag.* 22: 52; Zool. Soc. Kor., 1968: 49; Kor. Soc. Pl. Prot., 1972: 138. (Adult)

Dioryctria sylvestrella: Inoue, 1954, Check list of the Lepidoptera of Japan: 138; Mutuura, 1957, Moths of Japan in Color: 97; Forestry Research Institute, A list of forest insect pests in Korea: 91; Inoue, 1982, Moths of Japan, 1: 397, 2: 251, pl. 47: 68; Park, 1983, Insecta Koreana, 3: 152; Hirashima, 1989, A check list of Japanese Insect Ⅱ: 964; Byun, 1998, *FRI. J. For. Sci.* 59: 78. (Adult)



Figs. 7 – 12 *Dioryctria sylvestrella* (Ratzeburg)

7. larva; 8. mandible (dorsal view); 9. head (dorsal and ventral view); 10. maxillae and labium; 11. labrum and epipharynx; 12. crochets. scales: 0.5 mm

Body grayish white; head reddish brown; thoracic shield dark brown; thoracic leg brown; anal shield brown; setae pinacula distinct and darker than the body color; spiracles pale yellowish brown with dark brown peritrems.

Head. Ocellar area more rounded than angular; the distance from vertical triangle to apex of ecdysial lines greater than the distance from apex of ecdysial lines to apex of frontal sutures; the front extending two-thirds of the distance to epicranial notch. A1, A2 and A3 forming an obtuse angle at A2.

Mouthparts. Labrum emargination one-sixth deep, forming an arc; M2 laterodorsal to M1; L1 and L2 closely approximate, L1 posterodorsal to L2. Mandible with five distinct apical teeth on cutting edge. Labium having membranous postmentum with two conspicuous setae, a dark pigmentation rounded them; mentum sclerotized; prementum with the median spinneret distally and labial palpi laterally; the spinneret apical rounded, about 11 times as long as median breadth, and slightly longer than tip of seta on apical segment of labial palpi. Maxillae: cardo mostly membranous, with hook-like sclerites basely; stipes with dark sclerites and two setae; palpifer sclerotized and with one seta. Palpus: basal segment with a maxillary lobe and one seta, the lobe with three sensilla trichodea (two setae forked), two sensilla styloconica, and three small sensilla basiconica and one puncture; median segment equal to apical segment and with one puncture; apical segment with eight small sensilla basiconica distally.

Thorax. T1: D1 usually closer to D2 than to XD1; XD2, SD1 and SD2 forming an acute angle at SD1, L1 and L2 positioned at center of L pinaculum; SV1 and SV2 present above leg. T2 and T3: D1 and D2, SD2 and SD1 on same pinaculum; a dark ring around seta SD1 and center light on T2; L1, L2 and L3 present; SV group unisetose. Thoracic leg: coxa with seven setae; femur with two setae; tibia with six setae and one puncture; tarsus with four small setae.

Abdomen. On A1-8, D1 anterodorsal to D2 and shorter than D2; SD1 dorsal to the spiracle; a dark ring around SD1 seta and center pale on A8; SD2 minute; L3 posteroventral to setae L1 and L2 pinaculum. On A9, D2 pinaculum fused from dorsum; D1 and SD1 on the same pinaculum; L group trisetose. Anal shield rounded posteriorly, anal legs with nine setae and one puncture. SV group on abdominal segments 1, 2, 7, 8 and 9 usually 3:3:2:2:2. Crochets of A3-6 biordinal, arranged in a circle; anal legs arranged in a semicircle biordinal crochets. All spiracles circle, those on T1 and A8 of about the same size, larger than the others.

Larva length: 16 ~ 25 mm. Head width: 1.5 ~ 1.8 mm.

Materials examined: Mature larvae collected from cones of *Pinups koraiensis* S. *et* Z. at the Experiment Forest of Kangwon National University, Chunchon City, Kangwon Do, 9. Ⅸ. 1997.

This species is easily separable from relatives by the maxillary lobe with two forked sensilla trichodea; a dark ring rounded SD1 and center pale on T2 and A8; setae D1 and SD1 on the same pinaculum on A8; setae L1 and L2 positioned center of L pinaculum on T1.

Family Geometridae

Subfamily Larentiinae

Genus *Eupithecia* Curtis, 1825

***Eupithecia abietaria debrunneata* Staudinger** 1897 (Figs. 13 ~ 18)

Eupithecia abietaria debrunneata Staudinger, 1897, *Dt. Ent. Z. Iris* 10: 109; Lempke, 1969, *Tijd. Ent.* 112: 29; Inoue, 1979, *Bull. Fac. Domestic Sci*, 15: 159; Inoue, 1982, Moth of Japan, 1: 499, 2: 286, 76: 48-50, 329: 1; 331: 3; 336: 1. (Adult)

Tephroclystia togata var. *debrunneata*: Staudinger, 1901, Cat. Lep. Pal. (ed. 3), 1: 310. (Adult)

Eupithecia abietaria f. *debrunneata*: Dietze, 1913, *Biol. Eupith.* 2: 32, pl. 69: 61, 62. (Adult)

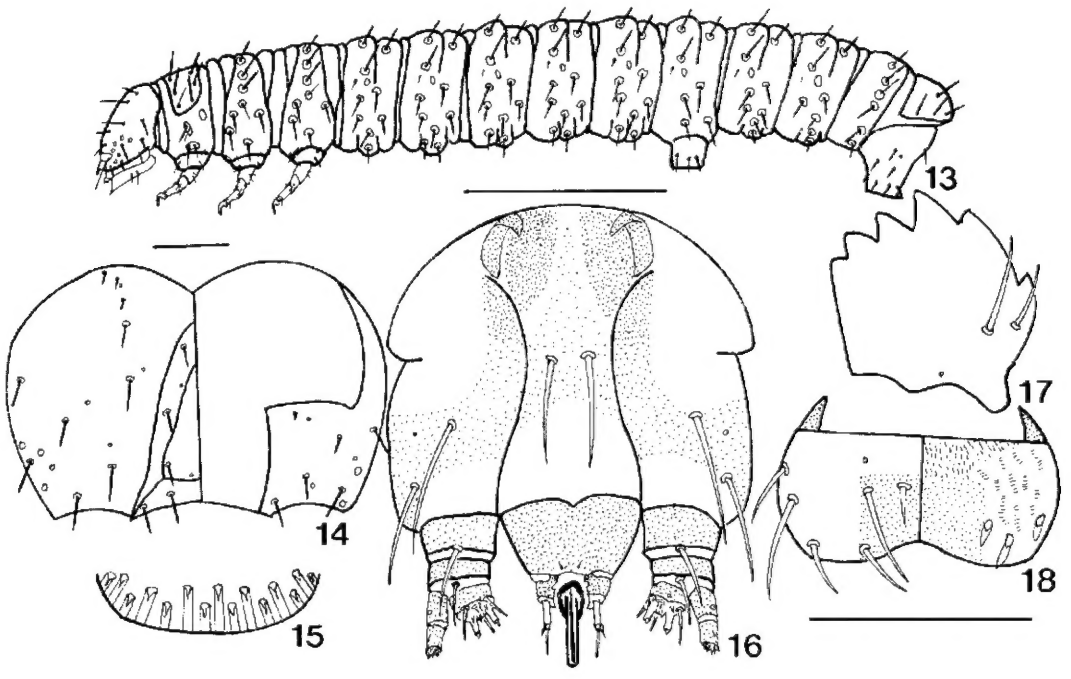
Eupithecia pini debrunneata: Prout, 1914, in Seitze, Macrolep. 4: 276. (Adult)

Eupithecia rufescens: Matsumura, 1925, *J. Coll. Agr. Hokkaido Imp. Univ.* 15 (3): 171 (nec Butler).

Eupithecia strobilata debrunneata: Inoue, 1955, *Tinea* 2: 80; Inoue, 1956, Check List Lep. Jap. 3: 289; Inoue, 1957, in Icon. Het. Jap. Col. Nat. [1]: 225, pl. 43: 1181; Inoue, 1959, in Icon. Ins. Jap. Col. Nat. Ed. 1: 198, pl. 139: 7. (Adult)

Body yellowish brown; head pale brown; thoracic shield slightly darker than body color; anal shield brown; spiracles yellow with brown peritrems; cuticle granular.

Head. Ocelli Ⅰ ~ Ⅳ almost forming a semicircle



Figs. 13 – 18 *Eupithecia abietaria debrunneata* Staudinger
13. larva; 14. head (dorsal and ventral view); 15. crochets; 16. maxillae and labium;
17. mandible (dorsal view); 18. labrum and epipharynx. scales: 0.5 mm

and evenly placed; the distance from vertical triangle to apex of ecdysial lines slightly shorter than the distance from apex of ecdysial lines to apex of frontal sutures; front extending two-thirds of the distance to epicranial notch; A1, A2 and A3 forming an acute angle at A2.

Mouthparts. Labrum emargination one-sixth deep, forming normal arc; M2 directly lateral to M1; L1 and L2 not approximate, L1 lateroposteral to L2. Mandible with six apical teeth on cutting edge, the first tooth low. Labium having membranous postmentum with two conspicuous setae, a dark pigmentation around them; mentum sclerotized; prementum with median spinneret distally and labial palpi laterally; spinneret rounded at apex, about 8 times as long as median breadth, and longer than tip of seta on apical segment of labial palpi. Maxillae: cardo mostly membranous, with hook-like sclerites basally; stipes with dark marking and two setae; palpifer sclerotized and with one seta. Palpus: basal segment with a lobe and one seta, on the lobe with two sensilla styloconica, three sensilla trichodea, and two sensilla basiconica and one puncture; median segment subequal to apical segment and with one puncture; apical segment with eight sensilla basiconica distally.

Thorax. T1: D1 closer to D2 than to XD1; XD1, XD2 and SD1 forming an almost vertical line; XD2, SD1 and SD2 forming an almost right angle at SD1; SD1 thinner than SD2; L group bisetose, L2 thinner than L1; SV1 and SV2 present above leg. T2 and T3: setae D1, D2, SD2 and SD1 arranged a straight vertical line; L1, L2 and L3 present; SV group unisetose. Thoracic leg: coxa with seven setae; femur with two setae; tibia with six setae and one puncture; tarsus with four setae.

Abdomen. On A1-8, D1 anterodorsal to D2; SD1 anterodorsal to the spiracle except for A1 (SD1 dorsal to the spiracle). SD2 present; L1 lateroventral to the spiracle; L2 anteroventral to spiracle in A1-6 and A8, straight below from spiracle in A7; L3 below from L2; SV3 almost caudad of L3 on A1-7, L3 and SV3 closely approximate on A7. SV group bisetose on A1 and A7, trisetose on A2-5, four SV setae on A6, unisetose on A8. On A9, D2, D1, SD1, L1 and SV1 forming a straight vertical line. Anal shield rounded posteriorly; anal legs with nine setae and one puncture, lateral setae straight arranged, L1 most dorsal and L3 most ventral. Crochets of A6 and A10 biordinal, arranged a transverse row. All spiracles oval, those on T1 and A8 of about same size and larger than others.

Larva length: 20 ~ 25 mm; Head width: 2.3 ~ 2.7

mm.

Materials examined: Mature larvae collected from cones of *Pinus koraiensis* S. *et* Z. at the Experiment Forest of Kangwon National University, Chunchon City, Kangwon Do, 23. Ⅸ. 1997.

This species may be characterized by the dark pigmented area round two postmentum setae of labium; spinneret apical rounded; mandible with six apical teeth; labrum emargination forming normal arc, seta M2 lateral to M1, L1 and L2 not approximate, L1 laterodorsal to L2; crochets biordinal absent fleshy lobe.

Key to the species examined

1. Crochets on ventral prolegs in a complete circle; on A1-8, setae L1 and L2 adjacent ····· 2
   Crochets on ventral prolegs in a mesoseries; on A1-8, setae L1 and L2 distant ····· ***Eupithecia abietaria debrunneata***
2. Setae D1 and SD1 pinacula separated on A8; setae L1 and L2 positioned posterior of L pinaculum on T1 ····· ***Dioryctria abietella***
   Setae D1 and SD1 on the same pinaculum on A8; setae L1 and L2 positioned center of L pinaculum on T1 ····· ***Dioryctria sylvestrella***

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在韩国危害红松球果的三种蛾类幼虫形态记述

(鳞翅目)

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摘要: 详细地记述了韩国红松球果害虫冷杉梢斑螟 *Dioryctria abietella*、赤松梢斑螟 *D. sylvestrella* (螟蛾科) 和小花尺蛾 *Eupithecia abietaria debrunneata* (尺蛾科) 幼虫的形态特征, 并提供了形态特征图。

关键词: 鳞翅目; 螟蛾科; 尺蛾科; 幼虫形态; 韩国

中图分类号: Q969.42 **文献标识码**: A **文章编号**: 0454-6296 (2002) 03-0371-06